Modeling and Classification of the ST-T Segment Morphology for Enhanced Detection of Acute Myocardial Infarction

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Background: A number of cardiac conditions such as acute pericarditis (PC) and early repolarization (ER) cause ST elevation which mimics ST-segment elevation acute myocardial infarction (STEMI). Current guidelines recommend analyzing ST-T segment morphology to distinguish STEMI from these confounders. In PC and ER (and occasionally in STEMI) ST elevation is concave upward, while a convex or straight ECG ST-T segment is associated with the diagnosis of STEMI. We developed an algorithm to classify concavity characteristic of the ST-T segment.

Method: We developed a quadratic polynomial regression algorithm to classify the morphology of the ST-T segment in patients diagnosed with STEMI, PC, or ER. Representative beats, ST levels, and the fiducial points were determined by a diagnostic ECG algorithm in 10-second, 12-lead ECG recordings. Our least squares regression algorithm modeled ST-T segment by a parabola (Figure 1), and determined the curvature, vertex, and opening direction of the fitted parabola, in addition to R-squared and noise measure. These features were applied to a bootstrap-aggregated tree ensemble to classify the ST-T segment shape.

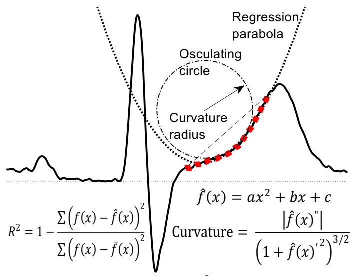

Figure 1. Example of quadratic polynomial regression of the ST-T segment and a curvature radius

Results: We evaluated our algorithm on a 12-lead ECG database collected in two medical centers that included STEMI (n=100), PC (n=100), and ER (n=100). The database contains 2,541 leads with ST elevation of at least 10µV. Defining a positive event as detecting visible upward concavity in representative beats, Table 1 summarizes the performance of this algorithm using 10-fold cross validation. Also listed for comparison is the performance of a simple method that determines the direction of the ST-T segment with respect to a line connecting its boundaries, using their maximum distance.

Table 1. Regression algorithm performance comparted to a simple method

Algorithm	Se (%)	Sp (%)	PPV (%)	NPV (%)
Regression	91	97	90	97
Simple	81	88	53	96

Conclusions: Morphology analysis of the ST-elevation by a regression model showed significant improvement versus a simple method. False detections are mostly due to the borderline concavity, inaccuracies in the ST-T segment boundaries, and nonlinearity in the curvature equation.